

CPUE

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Hypothesis

- 1) H_0 : There is no difference in cpe (catch/hour) among years 2013 - 2016.
- 2) H_0 : There is no differenct in cpe for quality length (300mm) and larger largemouth bass among years 2013 - 2016.
- 3) H_0 : There is no difference in cpe for largemouth bass smaller than quality length (300mm) among years 2013 - 2016.
- 4) H_0 : There is no difference in CPUE of Stock to Quality length largemouth bass among years 2013 - 2016.
- 5) H_0 : There is no difference in CPUE of Quality to Preferred length largemouth bass among years 2013 - 2016.

1) H_0 : There is no difference in cpe (catch/hour) among years 2013 - 2016.

Load and Prepare Data

Load Data

```
gcat <- read.csv("Data/Clean-Data/CPUE-gcat_2013-2017.csv") %>% filterD(Year <
  2017) %>% filterD(Species == 317) %>% arrange(Site, Year)

gcat$Site <- factor(gcat$Site)

cpeSum <- aggregate(cpe.hr ~ Year + Site, data = gcat, FUN = sum)
```

Year	Site	cpe.hr
2014	1	45.378151
2013	2	86.746988
2014	2	87.032967
2015	2	19.169326
2016	2	59.602650
2013	4	58.009479
2014	4	19.933555
2015	4	31.259041
2016	4	48.949318
2015	5	4.225352
2013	6	4.712042
2014	6	21.021898
2015	6	17.716535
2016	6	44.628097
2013	8	38.709677
2014	8	47.787611
2015	8	117.249701
2016	8	166.591420
2013	10	20.571429
2014	10	27.799228
2016	10	5.872757

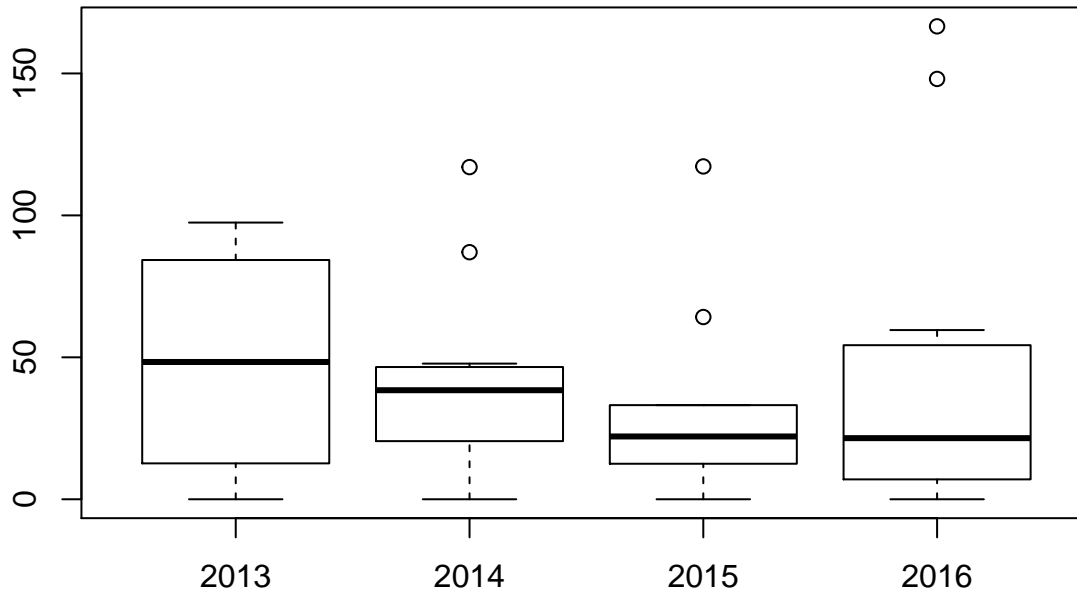
	Year	Site	cpe.hr
22	2014	11	117.009751
23	2015	11	33.162749
24	2016	11	26.438189
25	2014	12	36.468886
26	2015	12	12.514485
27	2016	12	10.404620
28	2016	13	0.000000
29	2016	14	8.135593
30	2013	15	81.818182
31	2014	15	40.346409
32	2015	15	25.079168
33	2016	15	16.618585
34	2014	16	45.120859
35	2013	18	97.472924
36	2014	18	16.775396
37	2015	18	64.197532
38	2016	18	148.064520
39	2013	19	0.000000
40	2014	19	0.000000
41	2015	19	0.000000
42	2016	19	0.000000

Test Hypothesis 1

```
aov1 <- aov(cpe.hr ~ Year, data = cpeSum)
summary(aov1)
```

```
##           Df Sum Sq Mean Sq F value Pr(>F)
## Year       1    121    121.3    0.071  0.792
## Residuals  40   68501    1712.5
```

Mean Catch Per Hour



```
## Year cpe.hr
## 1 2013 48.35958
## 2 2014 38.40765
## 3 2015 22.12425
## 4 2016 21.52839
```

Results H_0 1

There is *no significant difference* in CPUE among years **2013-2016** ($F_{1,40} = 0.071$, $p = 0.792$). The median CPUE was 48.36 in **2013**, 38.41 in **2014**, 22.12 in **2015**, 21.53 in **2016**.

2) H_0 : There is no different in cpe for quality length (300mm) and larger largemouth bass among years 2013 - 2016.

Load and Prepare Data

Load Data with Gcat and make Q+ and Q-

```
## Year Site effort Species gcat caught cpe.hr
## 1 2014 1 0.2644444 317 stock 9 34.03361
## 2 2014 1 0.2644444 317 quality 3 11.34454
## 3 2014 1 0.2644444 317 substock 0 0.00000
## 250 2016 19 0.2322222 317 preferred 0 0.00000
## 251 2016 19 0.2322222 317 memorable 0 0.00000
## 252 2016 19 0.2322222 317 trophy 0 0.00000
```

```
##           Year
## gcat      2013 2014 2015 2016
## memorable    0    0    0    0
## preferred   14   18   15   10
## quality     39   57   38   47
## stock       38   65   14   53
## substock    16    3   13   34
## trophy      0    0    0    0
```

Make Qcat Variable and Data Frame

```
Qcat <- gcat %>% mutate(gcatQ = mapvalues(gcat, from = c("substock", "stock",
  "quality", "preferred", "memorable", "trophy"), to = c("quality-", "quality-",
  "quality+", "quality+", "quality+", "quality+"))) %>% dplyr::select(Year,
  Site, gcatQ, cpe.hr)
```

Create Data Frame With Only Quality + Fish

```
Qpls <- Qcat[Qcat$gcatQ == "quality+", ]
Qpls$gcatQ <- droplevels(Qpls$gcatQ)
```

```
str(Qpls)
```

```
## 'data.frame': 168 obs. of 4 variables:
## $ Year : int 2014 2014 2014 2014 2013 2013 2013 2013 2014 2014 ...
## $ Site : Factor w/ 15 levels "1","2","4","5",...: 1 1 1 1 2 2 2 2 2 2 ...
## $ gcatQ : Factor w/ 1 level "quality+": 1 1 1 1 1 1 1 1 1 1 ...
## $ cpe.hr: num 11.3 0 0 0 23.7 ...
```

```
Qpls.sum <- aggregate(cpe.hr ~ Year + Site, data = Qpls, FUN = sum) %>% arrange(Site,
  Year)
```

Year	Site	cpe.hr
2014	1	11.344538
2013	2	23.658269
2014	2	35.604396
2015	2	0.000000
2016	2	23.841060
2013	4	23.886256
2014	4	11.960133
2015	4	26.049200
2016	4	17.799750
2015	5	4.225352
2013	6	0.000000
2014	6	15.766423
2015	6	3.543307
2016	6	14.876030
2013	8	8.602151
2014	8	23.893805
2015	8	52.110981
2016	8	24.379230
2013	10	8.228571
2014	10	22.239382
2016	10	5.872757

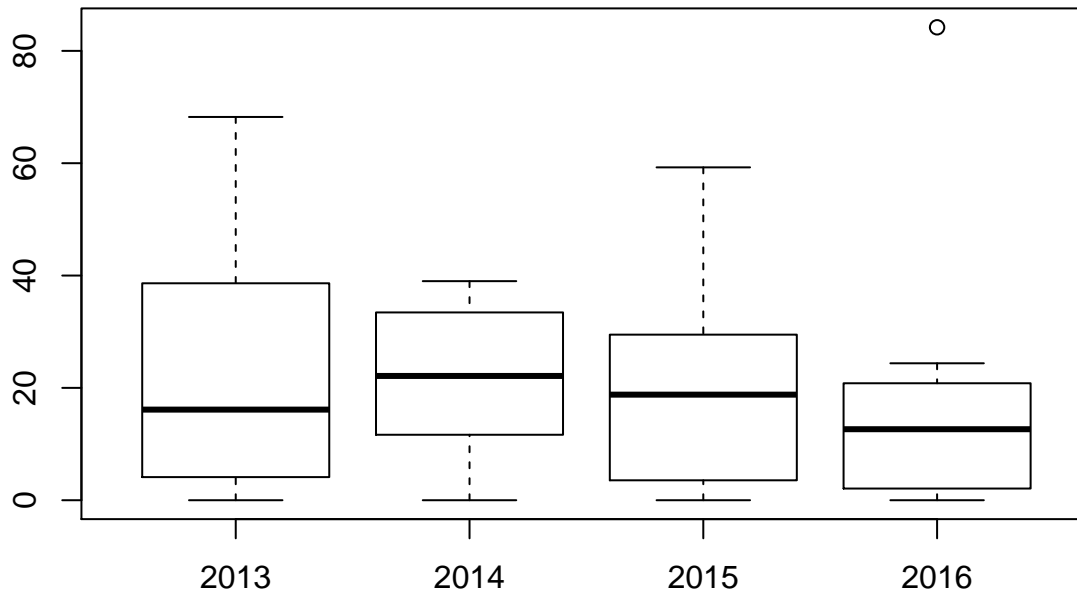
	Year	Site	cpe.hr
22	2014	11	39.003250
23	2015	11	29.478000
24	2016	11	17.625460
25	2014	12	31.259045
26	2015	12	12.514485
27	2016	12	10.404620
28	2016	13	0.000000
29	2016	14	0.000000
30	2013	15	53.359684
31	2014	15	22.007132
32	2015	15	25.079168
33	2016	15	4.154645
34	2014	16	38.675022
35	2013	18	68.231047
36	2014	18	10.065238
37	2015	18	59.259260
38	2016	18	84.193550
39	2013	19	0.000000
40	2014	19	0.000000
41	2015	19	0.000000
42	2016	19	0.000000

Test Hypothesis 2

```
aov.Qpls <- aov(cpe.hr ~ Year, data = Qpls.sum)
summary(aov.Qpls)
```

```
##           Df Sum Sq Mean Sq F value Pr(>F)
## Year       1    208   207.5    0.515  0.477
## Residuals  40 16111   402.8
```

Mean Catch Per Hour Quality +



```
##   Year  cpe.hr
## 1 2013 16.13021
## 2 2014 22.12326
## 3 2015 18.79683
## 4 2016 12.64033
```

Results H_0 2

There is *no significant difference* in CPUE for fish > Quality length (300mm) among years 2013 - 2016 ($F_{1,40} = 0.515$, $p = 0.477$). The median CPUE for largemouth bass Quality length and greater was 16.13 in **2013**, 22.12 in **2014**, 18.80 in **2015**, 12.64 in **2016**.

3) H_0 : There is no difference in cpe for largemouth bass smaller than quality length (300mm) among years 2013 - 2016.

Load and Prepare Data

Create Q- Data Frame

```
Qless <- Qcat[Qcat$gcatQ == "quality-", ]
Qless$gcatQ <- droplevels(Qless$gcatQ)
```

```
str(Qless)
```

```
## 'data.frame': 84 obs. of 4 variables:
## $ Year : int 2014 2014 2013 2013 2014 2014 2015 2015 2016 2016 ...
## $ Site : Factor w/ 15 levels "1","2","4","5",...: 1 1 2 2 2 2 2 2 2 2 ...
## $ gcatQ : Factor w/ 1 level "quality-": 1 1 1 1 1 1 1 1 1 1 ...
## $ cpe.hr: num 34 0 35.5 27.6 11.9 ...
```

```
Qless.sum <- aggregate(cpe.hr ~ Year + Site, data = Qless, FUN = sum) %>% arrange(Site,
Year)
```

Year	Site	cpe.hr
2014	1	34.033613
2013	2	63.088718
2014	2	51.428571
2015	2	19.169326
2016	2	35.761590
2013	4	34.123223
2014	4	7.973422
2015	4	5.209841
2016	4	31.149568
2015	5	0.000000
2013	6	4.712042
2014	6	5.255475
2015	6	14.173228
2016	6	29.752067
2013	8	30.107527
2014	8	23.893805
2015	8	65.138720
2016	8	142.212190
2013	10	12.342857
2014	10	5.559846
2016	10	0.000000

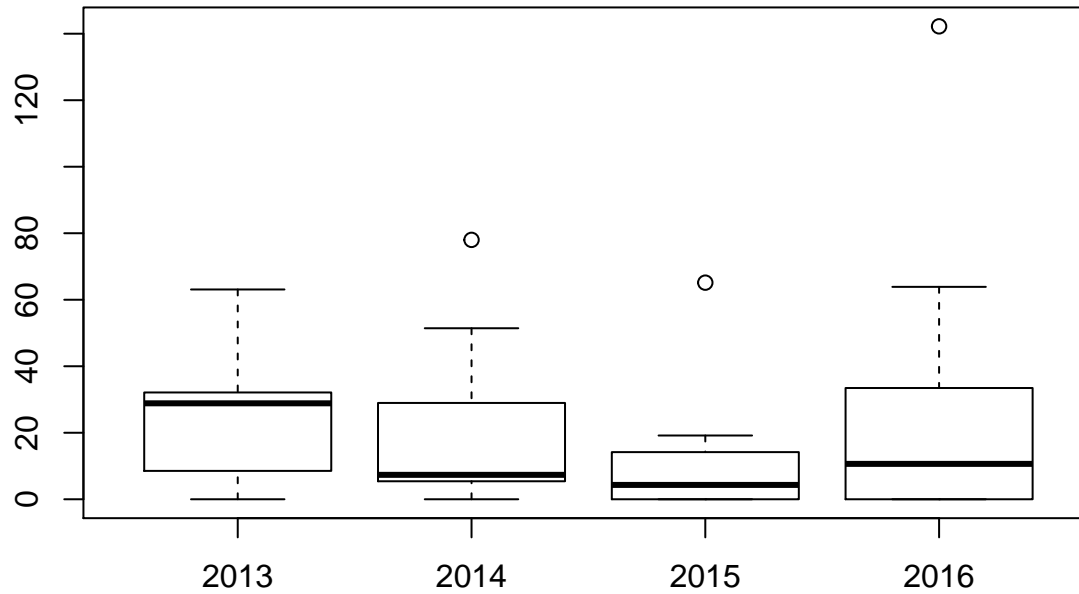
	Year	Site	cpe.hr
22	2014	11	78.006501
23	2015	11	3.684749
24	2016	11	8.812729
25	2014	12	5.209841
26	2015	12	0.000000
27	2016	12	0.000000
28	2016	13	0.000000
29	2016	14	8.135593
30	2013	15	28.458498
31	2014	15	18.339277
32	2015	15	0.000000
33	2016	15	12.463940
34	2014	16	6.445837
35	2013	18	29.241877
36	2014	18	6.710158
37	2015	18	4.938272
38	2016	18	63.870970
39	2013	19	0.000000
40	2014	19	0.000000
41	2015	19	0.000000
42	2016	19	0.000000

Test Hypothesis 3

```
aov.Qless <- aov(cpe.hr ~ Year, data = Qless.sum)
summary(aov.Qless)
```

```
##           Df Sum Sq Mean Sq F value Pr(>F)
## Year       1     12    11.5    0.014  0.906
## Residuals 40  32690   817.2
```

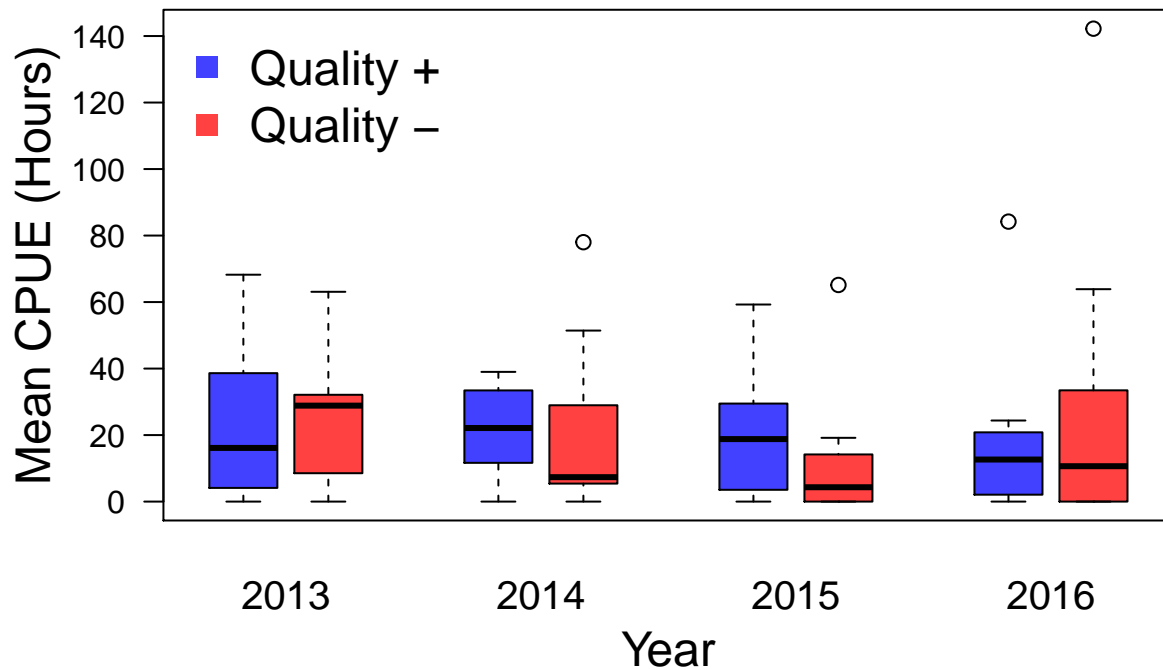
Mean Catch Per Hour Quality–



```
##   Year   cpe.hr
## 1 2013 28.850188
## 2 2014  7.341790
## 3 2015  4.311511
## 4 2016 10.638334
```

Results H_0 3

There is *no significant difference* in CPUE for fish < Quality length among years 2013 - 2016 ($F_{1,40} = 0.014$, $p = 0.906$). The median CPUE for largemouth bass less than quality length was 28.85 in **2013**, 7.34 in **2014**, 4.31 in **2015**, 10.64 in **2016**.



4) H_0 : There is no difference in CPUE of Stock to Quality length largemouth bass among years 2013 - 2016.

Load and Prepare Data

```
headtail(gcat)
```

```
##      Year Site   effort Species   gcat caught   cpe.hr
## 1    2014   1 0.2644444    317   stock     9 34.03361
## 2    2014   1 0.2644444    317   quality    3 11.34454
## 3    2014   1 0.2644444    317  substock    0  0.00000
## 250  2016  19 0.2322222    317 preferred    0  0.00000
## 251  2016  19 0.2322222    317 memorable    0  0.00000
## 252  2016  19 0.2322222    317   trophy    0  0.00000
```

```
sq <- gcat %>%
  filterD(gcat=="stock")
```

```
str(sq)
```

```
## 'data.frame':   42 obs. of  7 variables:
##  $ Year   : int   2014 2013 2014 2015 2016 2013 2014 2015 2016 2015 ...
##  $ Site   : Factor w/ 15 levels "1","2","4","5",...: 1 2 2 2 2 3 3 3 3 4 ...
##  $ effort : num   0.264 0.254 0.253 0.261 0.252 ...
##  $ Species: int   317 317 317 317 317 317 317 317 317 317 ...
##  $ gcat    : Factor w/ 1 level "stock": 1 1 1 1 1 1 1 1 1 1 ...
##  $ caught  : int    9  7 10  4  9  9  2  0  6  0 ...
##  $ cpe.hr  : num   34 27.6 39.6 15.3 35.8 ...
```


Year	Site	gcat	cpe.hr
2014	1	stock	34.033613
2013	2	stock	27.601314
2014	2	stock	39.560440
2015	2	stock	15.335460
2016	2	stock	35.761590
2013	4	stock	30.710901
2014	4	stock	7.973422
2015	4	stock	0.000000
2016	4	stock	26.699630
2015	5	stock	0.000000
2013	6	stock	4.712042
2014	6	stock	5.255475
2015	6	stock	7.086614
2016	6	stock	22.314050
2013	8	stock	17.204301
2014	8	stock	23.893805
2015	8	stock	30.398070
2016	8	stock	60.948080
2013	10	stock	12.342857
2014	10	stock	5.559846
2016	10	stock	0.000000

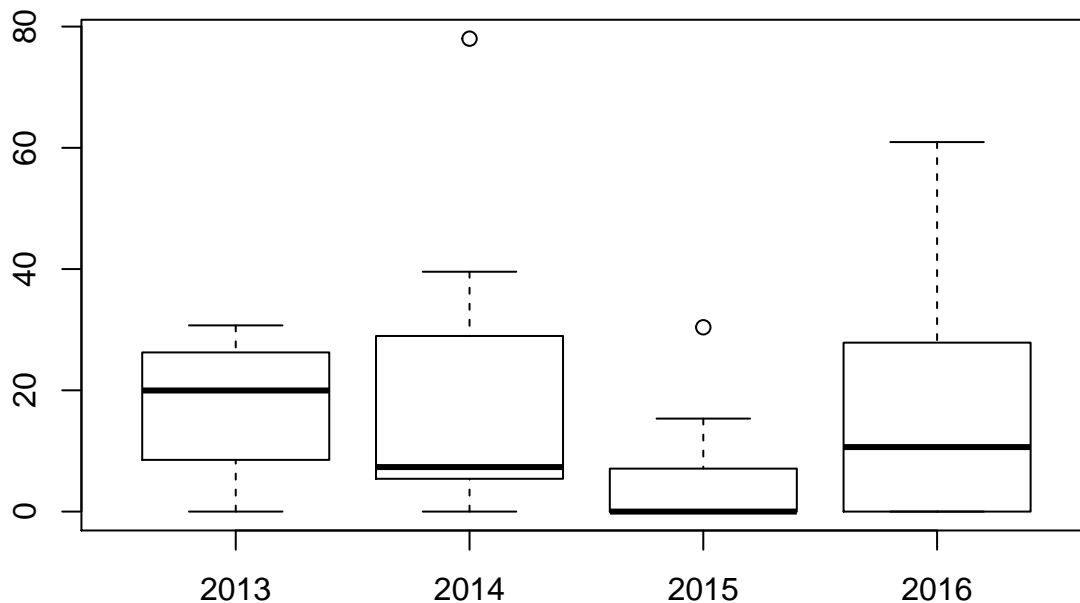
	Year	Site	gcat	cpe.hr
22	2014	11	stock	78.006501
23	2015	11	stock	3.684749
24	2016	11	stock	8.812729
25	2014	12	stock	5.209841
26	2015	12	stock	0.000000
27	2016	12	stock	0.000000
28	2016	13	stock	0.000000
29	2016	14	stock	8.135593
30	2013	15	stock	24.901186
31	2014	15	stock	18.339277
32	2015	15	stock	0.000000
33	2016	15	stock	12.463940
34	2014	16	stock	6.445837
35	2013	18	stock	22.743682
36	2014	18	stock	6.710158
37	2015	18	stock	0.000000
38	2016	18	stock	29.032260
39	2013	19	stock	0.000000
40	2014	19	stock	0.000000
41	2015	19	stock	0.000000
42	2016	19	stock	0.000000

Test Hypothesis 4

```
aov.sq <- aov(cpe.hr ~ Year, data = sq)
summary(aov.sq)
```

```
##              Df Sum Sq Mean Sq F value Pr(>F)
## Year          1    89   88.71    0.29  0.593
## Residuals    40 12239   305.96
```

Mean Catch Per Hour Stock – Quality



```
##   Year    cpe.hr
## 1 2013 17.527035
## 2 2014 19.249018
## 3 2015  5.650489
## 4 2016 17.013989

##   Year    cpe.hr
## 1 2013 19.97399
## 2 2014  7.34179
## 3 2015  0.00000
## 4 2016 10.63833
```

Results H_0 4

There is *no significant difference* in CPUE for fish *Stock to Quality* length among years 2013 - 2016 ($F_{1,40} = 0.29$, $p = 0.593$). The **median** CPUE for largemouth bass stock to quality length was 19.97 in **2013**, 7.34 in **2014**, 0.00 in **2015**, 10.64 in **2016**.

The **mean** CPUE for largemouth bass stock to quality length was 17.53 in **2013**, 19.24 in **2014**, 5.65 in **2015**, 17.01 in **2016**.

5) H_0 : There is no difference in CPUE of Quality to Preferred length largemouth bass among years 2013 - 2016.

Load and Prepare Data

```
headtail(gcat)
```

```
##   Year Site    effort Species    gcat caught    cpe.hr
## 1  2014   1 0.2644444    317    stock      9 34.03361
## 2  2014   1 0.2644444    317    quality     3 11.34454
## 3  2014   1 0.2644444    317   substock     0  0.00000
## 250 2016  19 0.2322222    317 preferred     0  0.00000
## 251 2016  19 0.2322222    317 memorable     0  0.00000
## 252 2016  19 0.2322222    317    trophy     0  0.00000
```

```
qp <- gcat %>%
  filterD(gcat=="quality")
```

```
str(qp)
```

```
## 'data.frame':  42 obs. of  7 variables:
## $ Year    : int  2014 2013 2014 2015 2016 2013 2014 2015 2016 2015 ...
## $ Site    : Factor w/ 15 levels "1","2","4","5",...: 1 2 2 2 2 3 3 3 3 4 ...
## $ effort  : num  0.264 0.254 0.253 0.261 0.252 ...
## $ Species: int  317 317 317 317 317 317 317 317 317 317 ...
## $ gcat    : Factor w/ 1 level "quality": 1 1 1 1 1 1 1 1 1 1 ...
## $ caught  : int   3  6  7  0  6  7  3  3  4  1 ...
## $ cpe.hr  : num  11.3 23.7 27.7  0 23.8 ...
```

Year	Site	gcat	cpe.hr
2014	1	quality	11.344538
2013	2	quality	23.658269
2014	2	quality	27.692308
2015	2	quality	0.000000
2016	2	quality	23.841060
2013	4	quality	23.886256
2014	4	quality	11.960133
2015	4	quality	15.629520
2016	4	quality	17.799750
2015	5	quality	4.225352
2013	6	quality	0.000000
2014	6	quality	10.510949
2015	6	quality	0.000000
2016	6	quality	14.876030
2013	8	quality	8.602151
2014	8	quality	19.911504
2015	8	quality	47.768400
2016	8	quality	24.379230
2013	10	quality	4.114286
2014	10	quality	11.119691
2016	10	quality	5.872757

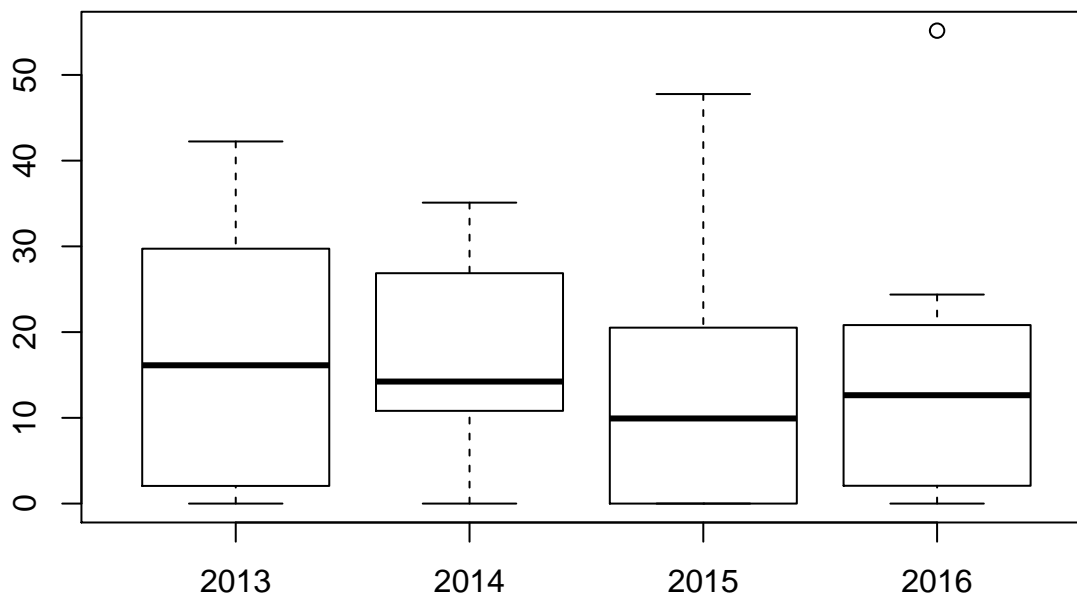
	Year	Site	gcat	cpe.hr
22	2014	11	quality	35.102925
23	2015	11	quality	18.423750
24	2016	11	quality	17.625460
25	2014	12	quality	26.049204
26	2015	12	quality	4.171495
27	2016	12	quality	10.404620
28	2016	13	quality	0.000000
29	2016	14	quality	0.000000
30	2013	15	quality	35.573122
31	2014	15	quality	16.505349
32	2015	15	quality	20.519320
33	2016	15	quality	4.154645
34	2014	16	quality	29.006267
35	2013	18	quality	42.238267
36	2014	18	quality	3.355079
37	2015	18	quality	39.506170
38	2016	18	quality	55.161290
39	2013	19	quality	0.000000
40	2014	19	quality	0.000000
41	2015	19	quality	0.000000
42	2016	19	quality	0.000000

Test Hypothesis 5

```
aov.qp <- aov(cpe.hr ~ Year, data = qp)
summary(aov.qp)
```

```
##           Df Sum Sq Mean Sq F value Pr(>F)
## Year      1     53   52.65    0.248  0.621
## Residuals 40  8491   212.28
```

Mean Catch Per Hour Stock – Quality



##	Year	cpe.hr
## 1	2013	16.130210
## 2	2014	14.232741
## 3	2015	9.927436
## 4	2016	12.640325

Results H_0 5

There is *no significant difference* in CPUE for fish *Quality to Preferred* length among years 2013 - 2016 ($F_{1,40} = 0.25$, $p = 0.621$). The **median** CPUE for largemouth bass quality to preferred length was 16.13 in **2013**, 14.23 in **2014**, 9.93 in **2015**, 12.64 in **2016**.